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THE SOIL AND GEOMORPHOLOGIC LIMITS BETWEEN THE COPOU HILLSLOPE AND CACAINA FLOODPLAIN (IASSY AREA)

M. Niculiță, C. Rusu
University Al. I. Cuza, Faculty of Geography and Geology, Department of Geography, Iaşi, Carol I, no. 20A, 700505, e-mail: mihai.niculita@uaic.ro

Limitele de sol şi geomorfologice dintre versantul dealului Copou şi lunca Cacainei (zona Iaşi)

Abstract

Soil geomorphology is seen as the area of interaction between pedology and geomorphology, studying the spatial and temporal relations between soil and landscapes. In this sense, the spatial relations between soil type and processes, and geomorphologic processes and landforms, from the Copou hillslope and Cacaina floodplain soil catena were investigated, using soil sections, field mapping, DEMs and geomorphometric landform classifications. These spatial relations were named limits, being separated two types of limits: an landslide lobe limit and an colluvium one.

Key words: soil geomorphology, soil catena, geomorphometrical landform classification, DEM

INTRODUCTION

The scientific area of interaction between pedology and geomorphology, soil geomorphology (pedogeomorphology) has its roots in the 19th century, and emerged as a recognized and developed branch in the 80s (Holliday, 2006). This field of research deals with the spatial and temporal relations between soil and landscape (Thornwaite, 2000; Wysocki et. al., 2000). Several concepts make possible the study of the relationships between soil and geomorphology: soil catena (Milne, 1934, 1936), geomorphic surfaces (Ruhe, 1956), chrono- and toposequences (Birkeland, 1999) and soil-landscape system (Huggett, 1975; Gerrard, 1981).

In the present paper we try to investigate the spatial relations between two components of a soil catena/soil-landscape system: the Copou hillslope and his neighbor, Cacaina floodplain (Figure 1) (Hilly plain of Jijia, Moldavian Plateau).

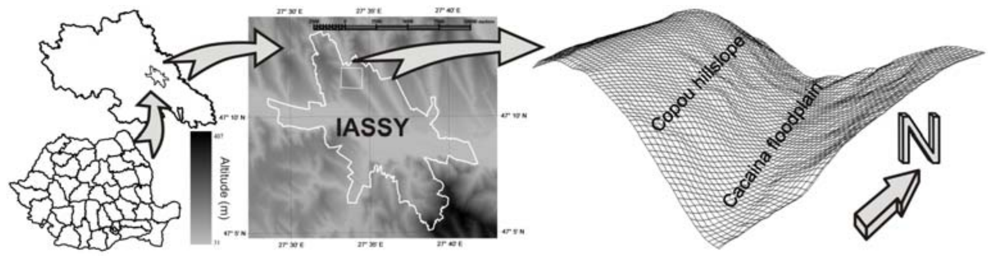

Fig. 1 Geographic position and of the studied area

MATERIALS AND METHODS

The relations between the two catena components were studied using two soil sections, digital elevation models (DEMs) of the area, geomorphometrical landform classifications and field mapping.

The two soil sections (Figure 2) were conducted and described using the standards of the Romanian methodology (Florea et. al., 1987), with a depth of minimum 150 cm for the main ones; sampling was continued in depth using an auger. Cylinders were used for soil bulk density probing.

The DEMs of the study area were interpolated from 2k and 25k topographic maps contours vertices x, y, z data using the multilevel B-spline (14 max. level) implemented in SAGA GIS 2.0.3. Were interpolated DEMs at 20 m and 10 m pixel size for the 25k source (1985 edition, 5 m equidistance) and 10 m, 5 m and 1 m for the 2 k source (1964 edition, 1m equidistance). The slope (in degrees) was computed using the maximum gradient algorithm (arctangent from the maximum gradient chosen from all unsigned gradients between the central cell of a 3 x 3 pixels window and the 8 neighborhood cells) implemented with SML in TNTMips 7.3 GIS. The catchment area was computed using the Terrain Analysis/Compound Analysis function from SAGA GIS 2.0.3 (as the specific contributing area, defined by Gruber and Peckham, 2009). The altitude above channel (in meters) was computed in SAGA GIS 2.0.3 (as the difference between the DEM surface and an interpolated surface of channel heights). The curvatures (plan/contour curvature, profile/tangential curvature, maximum and minimum curvature, as presented by Schmidt et. al., 2003, in radians/meters) were computed using the algorithms of Schmidt et. al., 2003 and Olaya, 2009, implemented whit SML in TNTMips 7.3, after a modification of a SML script from Microimages Inc. (http://www.microimages.com/sml/surfcurv.htm). The used geomorphometric parameters on a SV corner – NW corner section of the area are represented in Figure 3.

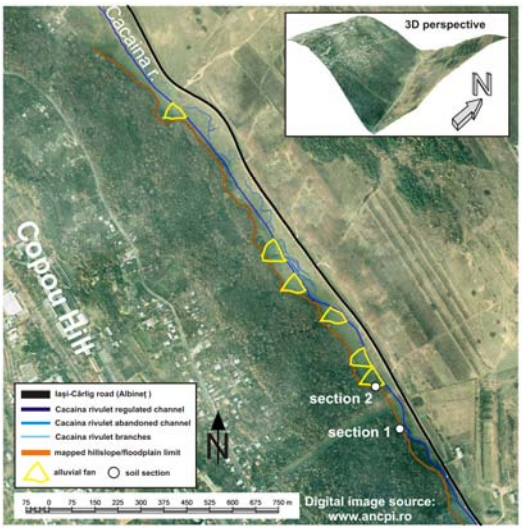

Fig. 2 The position of profile sections and mapped area

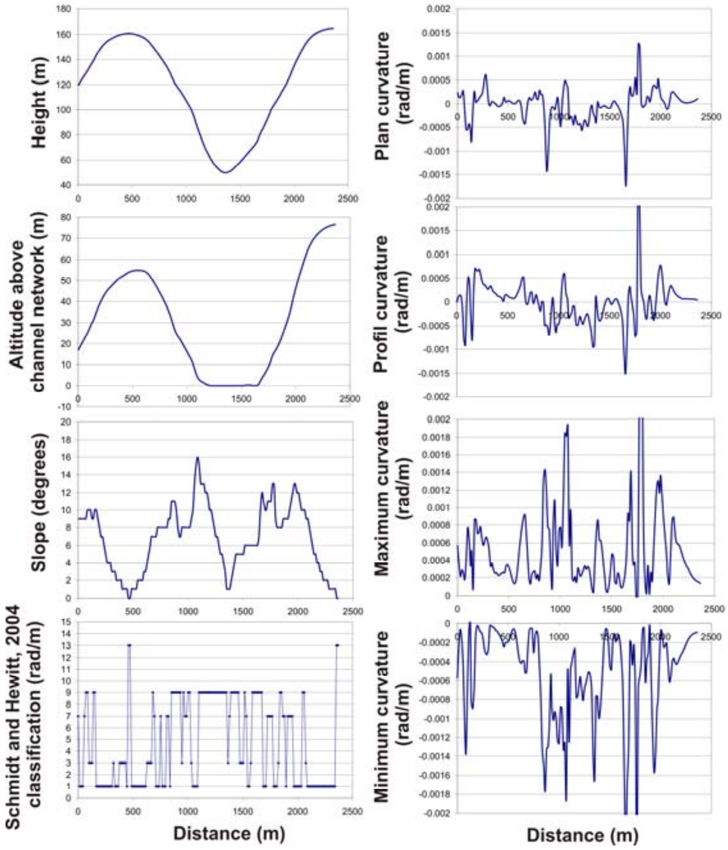

Fig. 3 Sections representing the computed geomorphometrical parameters from the DEM 25k 10 m

The geomorphometrical landform classifications (as shown by MacMillan and Shary, 2009) were performed using a soil catena approach and the Schmidt and Hewitt (2004) methodology, with implementation using SML in TNTMips 7.3.

The soil catena approach geomorphometric landform classification delineates the ridge, the hillslope and the floodplain. The ridge is the area with gentle slope (under or equal with 5º) and specific contributing area under or equal to 300. The floodplain is the area with altitude above channel bellow or equal with 1 m. The hillslope class was assigned to the other pixels (Figure 3 and Figure 4). This classification was applied only to the 25k DEM because the 2k DEM doesn't cover enough area to compute the channel level for altitude above channel network. The threshold values were chosen as the median of the most frequent class of geomorphometrical parameter which overlap the field mapped limit, and which are assumed to be constant for the entire study area.

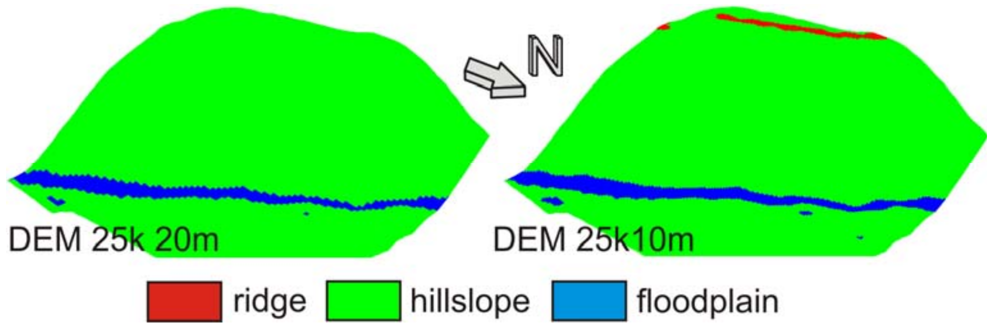

Fig. 4 3D perpsective of catena geomorphometrical classification

The curvature based classification follows the Schmidt and Hewitt (2004) methodology, with 9 classes of hillslopes (steep areas, when slope > 0) based on the profile/contour and plan/tangential curvature and with 6 classes for flat areas (ridges and channels, when slope = 0) based on maximum and minimum curvature (Figure 5) (convex > 0, straight = 0, concave < 0).

The field mapping was performed with a Mobile Mapper GPS and sub-metric accuracy. The geomorphometric gradient change between the steep hillslope and the gentle sloped floodplain were mapped (Figure 2).

RESULTS AND DISCUSSIONS

The studied area is situated in the Moldavian Plateau, in the Hilly Plain of Jijia, with monoclinal argillaceous Miocene strata (with a 7-8 m/km NNW-SSW gradient) and cuestas landform. The climate is temperate continental with 9.5ºC mean annual temperature and 567.5 mm mean annual precipitations (for Iaşi meteorological station, situated in vicinity at 102 m).

The floodplain of Cacaina brook is gentle sloped, being covered at the vicinity with the Copou hillslope by alluvial fans, deposited by the branch streams and the drain channels from the north-western Copou hillslope. Cacaina is also named on old maps Cârlig, and his channel is at present regulated.

The Copou hillslope is affected by mass-wasting processes (note the declivous trees from Figure 7 and 8), with accentuation of movements in rainy periods (Macarovici, 1942, Băcăuanu, 1970, Martiniuc and Băcăuanu, 1982). Geomorphometrically, the hillslope is characterized by landslide lobes and landslide terraces (Fig. 6). The area was forested after the World War II, with deciduous trees (eg. *Acer platanoides*).

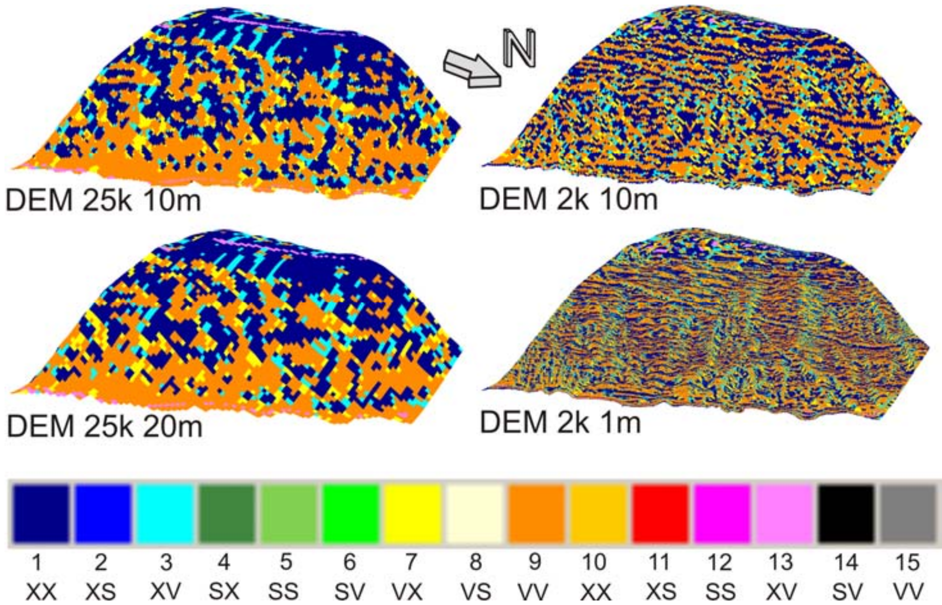

Fig. 5 3D perspective of the curvature based (Schmidt and Hewitt, 2003) geomorphometrical classification (the code of the color correspond to the Schmidt and Hewitt original notation)

Analyzing the soil sections we could separate two types of relations that we called limits. This term was used because the contact between the two catena units is geomorphometrically and pedologically abrupt. The typical soil-landscape system is formed by Chernozems and Regosols affected by landslides on hillslope and two-generations of soils, Phaeozems and Aluviosols on the floodplain. The buried Phaeozem corresponds to the initial level of the floodplain, the covering Aluviosol being related to the alluvial fans sedimentation of the tributary branches from north-western Copou hillslope.

The hillslope deposit covers the floodplain where the landslide movement was active recently. This is the general soil-landscape system of the area, the variations from it being related to the activity/inactivity of the landslide lobes. Where the lobes were active recently we will find the first type of limit, which corresponds to the

general soil-landscape system. When the lobes were inactive some time, the steep feature of the lobe was intensively washed by water, and the soil-landscape system supports another soil cover: a colluvic Aluviosol.

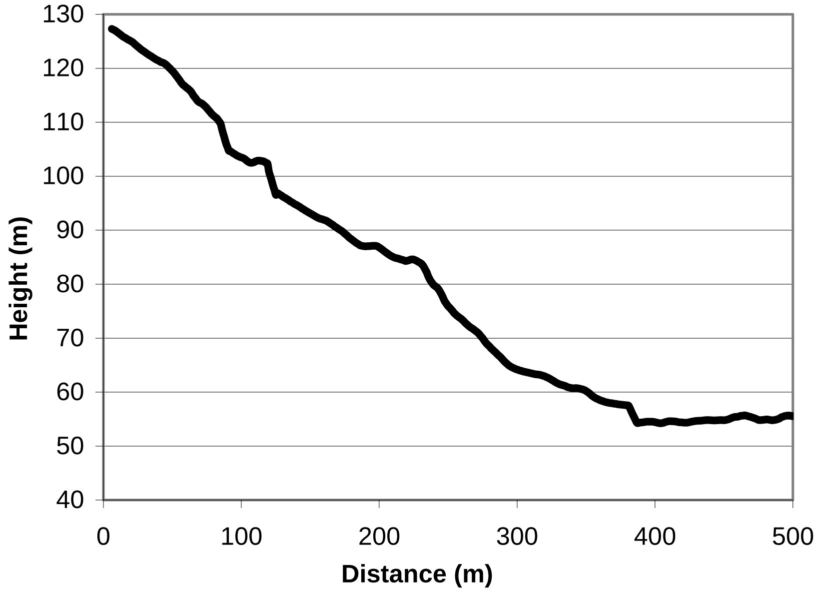

Fig. 6 GPS data section illustrating Copou hillslope morphology

The first type of limit, the landslide lobe limit (Figure 7) is characteristic to the active mass-wasting hillslope base. This type has a clearly steep form.

The second type of limit, the colluvial limit (Figure 8) is characteristic to the mass-wasting inactive hillslope base, where the material from the hillsope was transported by erosion and deposed as a colluvium blanket, area where we can separate a colluvial soil. In Figure 8 it can be seen on the schematically diagram of soil-landform system, on photographs and on the bulk density data, that there are two generations of colluvium deposits, one actually at the surface, and one captive between two successive alluvial fan deposits. This type of limit has a gentle form, but can be seen and mapped in the field.

The field mapped limit was compared with the geomorphometrically delineated limit (Figure 9). The maximum difference between the mapped and the 25 k DEM gomorphometrically classified limit is almost fourth and a half the DEM 25k 10m pixel size (we can assume landslide activity between 1964 - 1985 and the present time and some errors due to the stereorestitution method of topographic map creation).

The same field mapped limit was compared with the curvature geomorphometric landform classification to see if there is a form pattern related to the limit (Fig. 10). We can see the only 4 classes are represented on this limit, with the

following frequencies: class1 (XX-nose) 48%, class 3 (XV-hollow shoulder) 14%, class 7 (VX-spur foot) 8% and class 9 (VV- hollow foot) 30%.

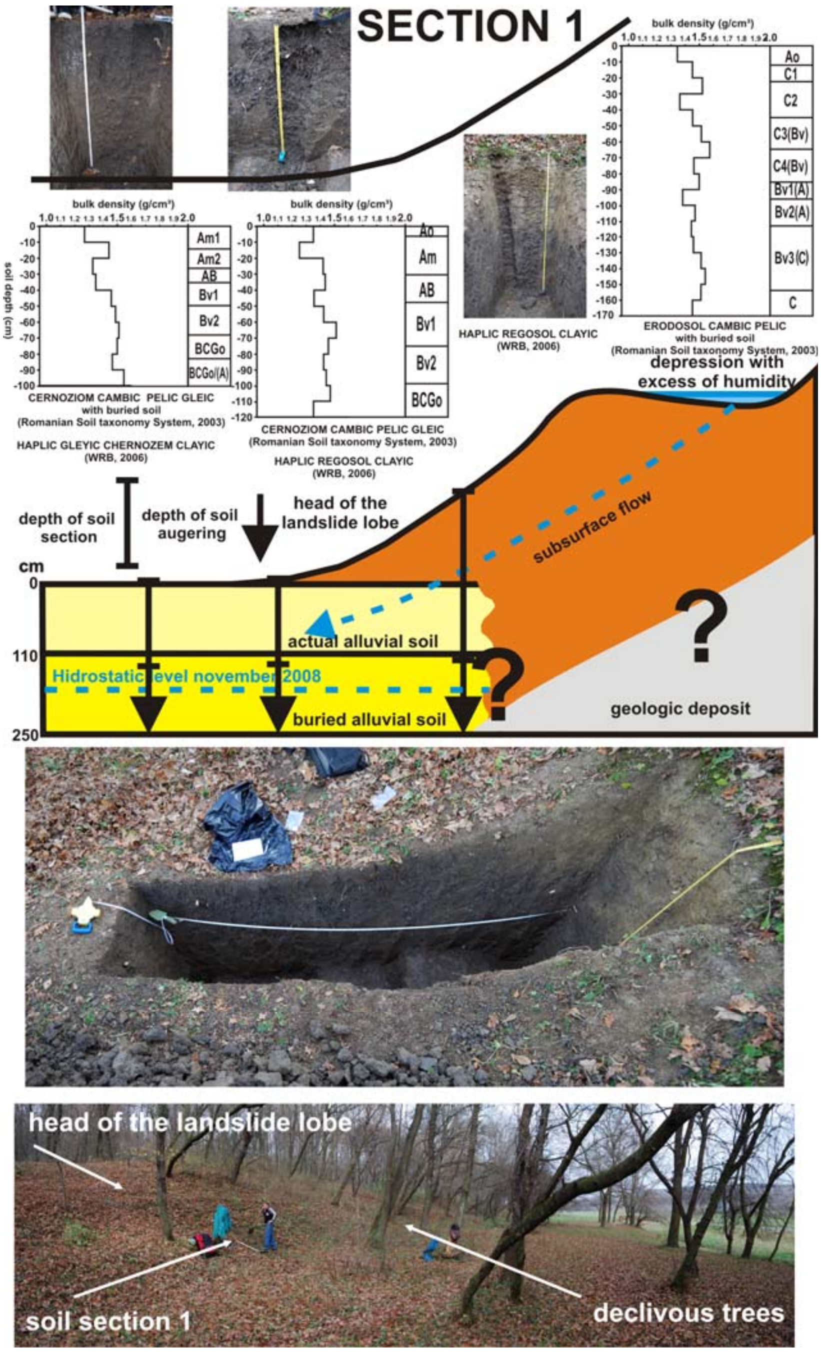

Fig. 7 Characterization of soil section 1: landslide lobe limit type

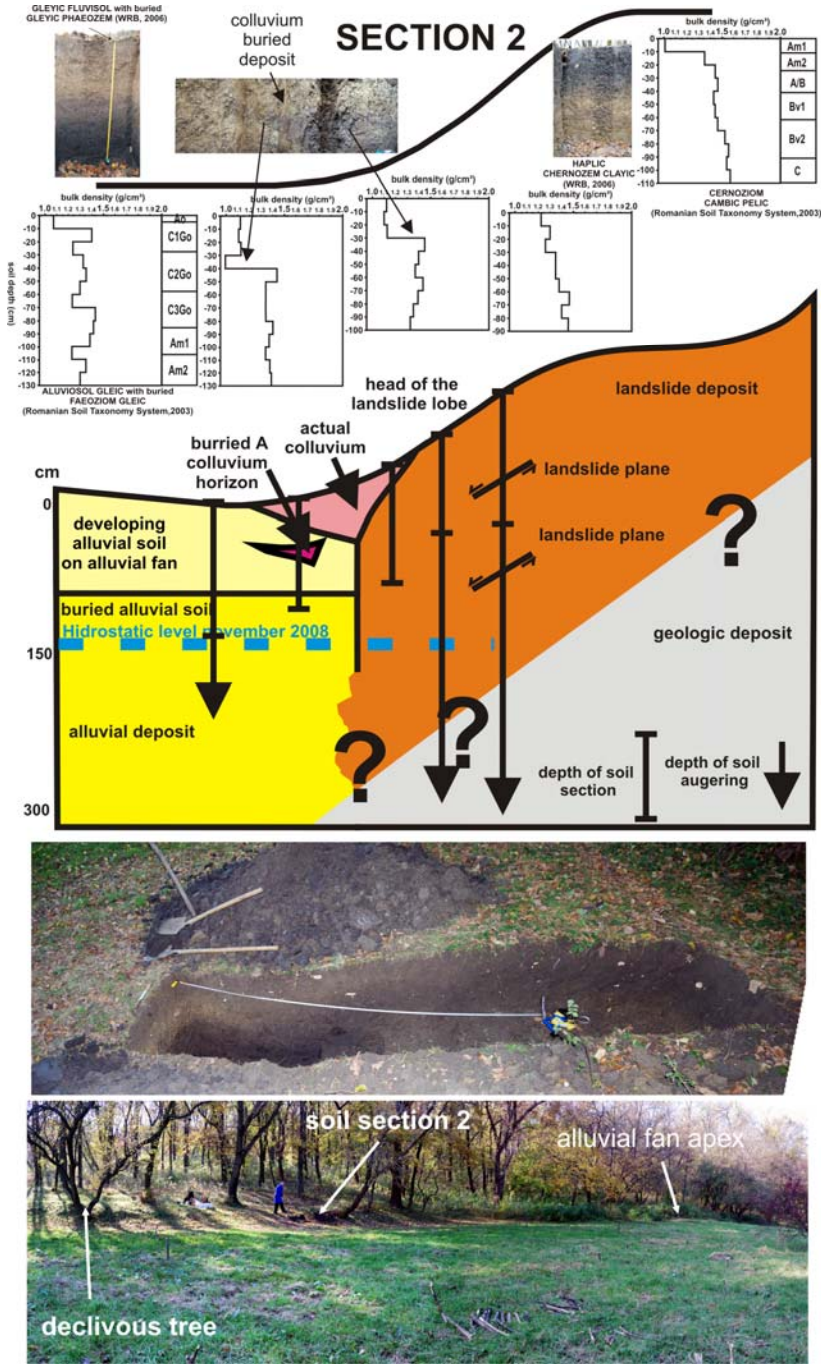

Fig. 8 Characterization of soil section 2: colluvium limit type

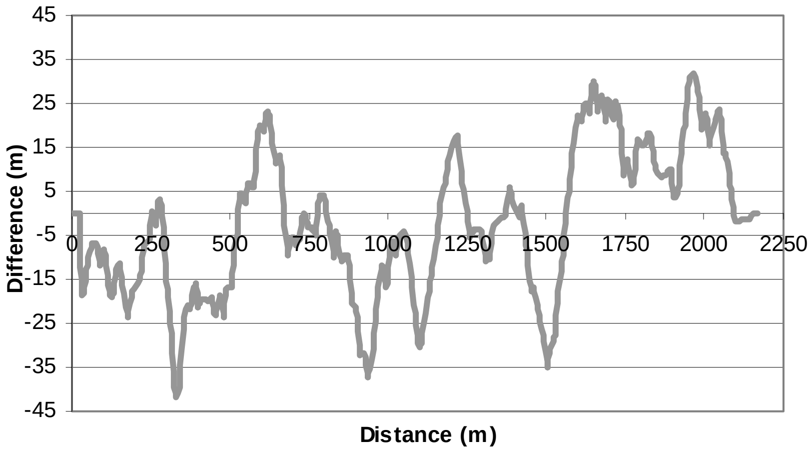

Fig. 9 Accuracy of catena geomorphometrical landform classification limit delineation (DEM 25k 10m) up against field mapped limit (positive values means left/west deviation and negative right/east, north viewing)

Making the following correspondence: landslide lobe limit type has class 1 form (nose) and class 3 form (hollow shoulder), colluvium limit type hhasave class 7 form (spur foot) and the area of alluvial fan has class 9 form (hollow foot), we can compute the proportion of the two types: the landslide lobe occupies 62% and the colluvium type 8%. Comparing the deviation of accuracy catena delineated limit and the curvature classification class (right and left) we can see that the classes 1, 3 and 7 correspond to right deviation and class 9 with left deviation, which seems logically, considering the possible error of stereorestitution/georeferencing.

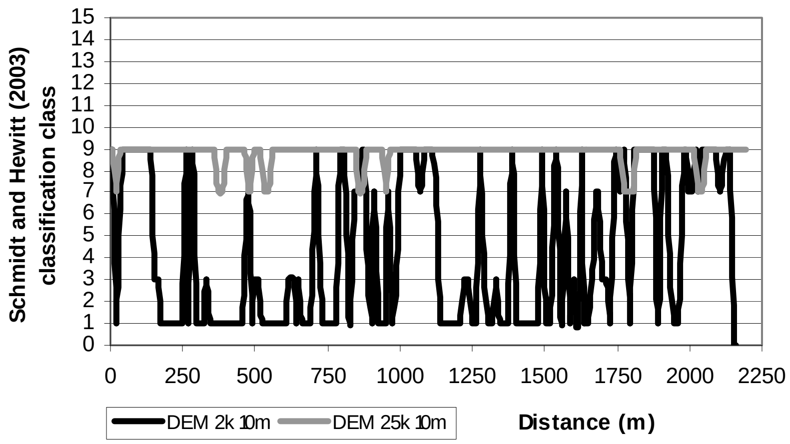

Fig. 10. The curvature classification

CONCLUSIONS

The present study try to sketch the spatial soil and geomorphologic conditions, processes and forms of the contact area between the mass-wasting Copou hillslope and Cacaina floodplain.

Is of real interest the possibility of using DEMs, geomorphometry and field mapping to extrapolate situations found in several soil sections.

A further soil-geomorphologic investigation is needed for the area to reveal the timing of the soil formation and geomorphologic processes evolution.

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